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MONSANTO CHEMICAL COMPANY
CLINTON LABORATORIES

DATE February 6, 1948

TO Dr. K. Z. Morgan

DEPARTMENT Health Physics

FROM Ross S. Thackeray

DEPARTMENT Health Physics

IN RE: A CRUDE ESTIMATE OF THE C^{14} IN THE PILE STACK GASES

An estimate of the C^{14} activity run out the pile stack in a day has been made for the current pile operating level of approximately 4000 KW. It is based on the measured argon activity in the stack gas in March, 1944¹. It was found then that there was 5.65×10^{-11} curies/cm³ of Argon⁴¹ when the pile was operating at 870 KW and the total exit cooling air flow was 51,000 ft³/min.

The total number of A⁴¹ curies exhausted per day now is found from the following formula:

$$5.65 \times 10^{-11} \text{ (curies/cm}^3\text{/870 KW of pile power)} \cdot \frac{4000}{870} \text{ (No. of 870 KW units)} \times 5.1 \times 10^4 \text{ (ft}^3\text{/min air flow)} \times 2.84 \times 10^4 \text{ (cm}^3\text{/ft}^3\text{)} \times 60 \text{ (min/hr)} \times 24 \text{ (hrs/day)} = 540 \text{ curies/day of A}^{41} \text{ at 4000 KW pile power.}$$

To calculate the amount of C^{14} currently being produced, we make the following statements and assumptions:

- 1) That the pile cooling air volume and pressure are the same as in 1944.
- 2) That in a given volume of air there are 170 times as many nitrogen atoms as argon atoms.
- 3) That the cross-section for .025 ev neutron absorption by Argon⁴⁰ is .62 barns².
- 4) That the cross-section for .025 ev neutron absorption by Nitrogen¹⁴ is 1.5 barns³. We assume here that the resonance absorption between .2 and 1.7 Mev is negligible.
- 5) That the half-life of C^{14} is 5100 years⁴.

CLASSIFICATION CANCELLED

DATE 8/28/67

For The Atomic Energy Commission

H. P. Canale
Chief, Declassification Branch

1. Kanne and Wilkenson, CP - 1300, March 6, 1944.

2 and 3. K. Way and G. Haines, Tables of Neutron Cross-Sections, Mon P - 405, October 31, 1947.

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K. Z. Morgan

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Accepting these statements, the curies per day of C^{14} released may be estimated from the curies per day of A^{41} by the following formula:

$$540 \text{ (curies of } A^{41} \text{ /day)} \times \frac{110}{5100 \cdot 365 \cdot 24 \cdot 60} \left(\frac{1/2 \text{ life of } A^{41}}{1/2 \text{ life of } C^{14}} \right) \\ \cdot \frac{1.5 \times 170}{.62} \left(\frac{\text{atoms of nitrogen activated}}{\text{atoms of argon activated}} \right) = .009 \text{ curies/day of } C^{14}$$

If it is assumed that the research pile will produce 3 times as much Argon⁴¹ as the X - pile, the expected C^{14} production would be approximately .03 curies/day.

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4. Reid, A. F. et al, Physical Review, 70, 431, 1946.
Morris, L. D., and Ingraham, M. G., Physical Review, 70, 772, 1946.
Morris, L. D., Mon P - 314, October, 1947.
Libby, W. F. et al, CC - 3780, May, 1947.

R. S. Thackeray

RST:mcc

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